SPECIFICATION

Electronic Version 1.2.8

Stylesheet Version 1.0

NIGHT LIGHT FOR PLUMBING FIXTURES

Background of Invention

[0001] The invention relates to the lighting arts. It is especially applicable to the nocturnal illumination of bathroom plumbing fixtures such as faucets, showerheads, toilets, and the like which produce an accessible water flow, and will be described with particular reference thereto. However, the invention will also find application in the illumination of plumbing fixtures in other settings where operation in darkness or other conditions of poor visibility is encountered, in the lighting and operative status indication (e.g., temperature, flow rate, et cetera) of fluid conduits conducting accessible or inaccessible flow of water or another fluid, and in other similar applications.

[0002] Rooms such as bathrooms can be very dark at night. Turning on the room light at night is uncomfortable to the eyes due to darkness-induced pupil dilation, and full illumination at daytime levels is typically unnecessary due to improved light collection of the dilated pupils as well as the adequacy of limited visibility for most bathroom-related activities. It is thus desired to provide a lower level of illumination for a bathroom at night.

[0003] In the past various devices, known as night lights, have been used for illuminating bathrooms and other dark places at night. These night lights typically employ incandescent bulbs or fluorescent tubes to provide a reduced level of illumination as compared with daytime lighting. The reduced light level produced by the night light is sufficient for using the bathroom facilities without being so bright as to be intrusive, disorienting, or even painful to individuals with darkness-induced pupil dilation.

[0004] These past night lights have several disadvantages. They usually monopolize an

electrical outlet. This is particularly problematic in modern bathrooms where a large number of electrical appliances are already employed, such as electric razors, hair dryers, air fresheners, and the like. In many such night lights, there is no power cable. Rather, the blades of the electrical plug are molded rigidly into the night light housing and the night light is affixed to the electrical outlet by the electrical plug blades. This can further limit the electrical outlet usage due to the size and unwieldiness of the affixed night light which not only occupies an outlet but also can block an adjacent outlet.

[0005] Past night lights are also not usually located in very close proximity to the bathroom sink, faucet, washbasin, showerhead, or other apparatus which is the destination of the night-wandering person's trek. As mentioned above, in many cases the night light is directly affixed to the electrical outlet by rigidly incorporated electrical plug blades. It is therefore located some distance away and does not illuminate the washbasin, toilet, or the like with good efficiency. Placement of conventional night lights near bathroom plumbing fixtures, especially faucets, is limited by safety concerns arising from an incompatibility of the 120 volt a.c. electrical power with the externally accessible water flow.

[0006] The spatial separation of past night lights from the washbasin also complicates the operation of the night light. In one operative method, the night light remains on constantly, or at least whenever the room is dark. This method wastes electricity, and can also produce stray light that can be annoying to sleeping individuals. Safety issues can also arise with an unattended conventional night light. In the case of an incandescent night light, a hot incandescent bulb is left unattended at night. In the case of a fluorescent night light, a source employing a high voltage electrical discharge is left unattended.

[0007]

In another operative method, the night light is manually switched on and off as needed. This method requires that night-wandering person physically access the night light, which as mentioned before is typically not located very close to the target plumbing fixture. This method disadvantageously leaves the user unaided in locating the night light in the dark. Such a situation is not only inconvenient, but can also be dangerous as the person is left to blindly probe in search of the electrically energized

device.

[0008] Yet another disadvantage of past night lights is that they are operatively disconnected from the associated plumbing fixture. For example, a conventional night light does not communicate with the washbasin faucet and cannot inform the user of its status. This can be problematic at night, because due to the reduced light levels (even with the night light) and the drowsy state of the night-wandering person, he or she is apt to be careless and run the faucet too hot or too cold, or at an undesirably high flow rate. A similarly dangerous situation can come to pass for an early-rising person attempting to take a shower in the dark, so as not to disturb other sleeping individuals.

[0009] Still yet another disadvantage of past night lights is that they do not take advantage of the aesthetically pleasing design of modern bathroom sinks, which often have acrylic or other multi-faceted light-transmissive and light-reflective handles. These handles can be difficult to see using past night lights due to the limited reflectivity of the light-transmissive material.

[0010] The present invention contemplates an improved apparatus and method that overcomes the above-mentioned limitations and others.

Summary of Invention

[0011] In accordance with one embodiment of the present invention, a night light for use in conjunction with an associated plumbing fixture is disclosed. The plumbing fixture includes a spout and a handle for controlling a water flow from the spout. The night light includes an LED arrangement comprising at least one LED disposed on or in the associated plumbing fixture for directly illuminating at least one of the handle, the water flow, and an associated basin.

[0012] In accordance with another embodiment of the present invention, a plumbing fixture is disclosed, including a showerhead or a faucet. The showerhead or faucet includes a water outlet for emitting a water flow and a handle for controlling the water flow. At least one LED is arranged on or in the showerhead or faucet and viewable by an associated user of the plumbing fixture. A light-transmissive encapsulant seals the LED and transmits light produced by the LED to the associated user. A controller

produces a controller output for controlling the LED light emission responsive to at least one of a water flow rate, a water flow temperature, an ambient light level, and a position of the handle.

[0013] In accordance with yet another embodiment of the present invention, a lamp is disclosed. The lamp is adapted for arrangement on a faucet or showerhead including spout and at least one handle for controlling a water flow out of the spout. The lamp includes: a printed circuit board with conductive traces arranged thereon; an LED source including at least one LED arranged on the printed circuit board and electrically powered via the conductive traces; and a light-transmissive encapsulant sealing the LED source and the conductive traces.

[0014] One advantage of the present invention resides in illuminating a faucet or showerhead feature such as a handle to facilitate a night wandering person in locating the control.

[0015] Another advantage of the present invention resides in providing a low power, hermetically sealed light source for the safe illumination of water-producing fixtures.

[0016] Another advantage of the present invention resides in providing visual feedback relating to water stream parameters such as the flow rate or the water temperature.

[0017] Yet another advantage of the present invention resides in automatic activation of night illumination under low-light conditions.

[0018] Still yet another advantage of the present invention resides in convenient retro-fitting of existing plumbing fixtures with lamps for providing night illumination, visual feedback information, or aesthetic value.

[0019] Numerous advantages and benefits of the present invention will become apparent to those of ordinary skill in the art upon reading and understanding the following detailed description.

Brief Description of Drawings

[0020]

The invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only

for purposes of illustrating the preferred embodiments and are not to be construed as limiting the invention.

[0021] FIGURE *1* shows an exemplary lavatory with a faucet that suitably practices an embodiment of the invention.

[0022] FIGURE *2* shows an exemplary lavatory with a faucet that suitably practices another embodiment of the invention.

[0023] FIGURE *3* shows an exemplary lavatory with a faucet that suitably practices yet another embodiment of the invention.

[0024] FIGURE *4* shows an exemplary lavatory with a faucet that suitably practices still yet another embodiment of the invention.

[0025] FIGURE *5* shows an exemplary lavatory that suitably practices an embodiment of the invention wherein the night light provides both illumination and a visual indication of the operative status of the lavatory.

[0026] IGURE *6* shows an exemplary lavatory with a centrally located single-handle faucet that suitably practices an embodiment of the invention.

[0027] FIGURE *7* shows a close up of the handle of the lavatory of FIGURE *6* with the night light arranged thereon.

[0028] FIGURE *8* shows an enlarged view of the night light of FIGURES *6* and *7*.

[0029] FIGURE *9* shows another embodiment of a handle-based night light for a single-handle faucet.

[0030] FIGURE *10* shows another embodiment of a single-handle lavatory including a night light in formed in accordance with yet another embodiment of the invention.

[0031] FIGURE *11* shows an enlarged view of the modified bottom faucet cover plate of FIGURE *10*.

[0032] FIGURE *12* shows a showerhead that suitably practices a detachably fastenable embodiment of the invention.

[0033] FIGURE *13* shows a showerhead with an LED lamp arranged on a shaft of a water flow control handle.

[0034] FIGURE *14* shows an exemplary electrical circuit for controlling LEDs based on an ambient light intensity.

[0035] FIGURE *15* shows an exemplary analog circuit for controlling a red and a blue LED responsive to a water flow temperature input.

[0036] FIGURE *16* shows an exemplary circuit for controlling a multi-color LED arrangement based on a water flow temperature input.

Detailed Description

[0037] With reference to FIGURE *1*, a lavatory *10* has a faucet *12* and a washbasin *14*. The faucet *12* includes a spout *16*, a hot water handle *18*, and a cold water handle *20*. The spout *16* delivers an accessible flow of water *22* responsive to turning on one or both handles *18*, *20*. The person using the lavatory *10* can control the water temperature and flow rate in an open-loop fashion by adjusting the settings of the hot and cold water handles *18*, *20* to suit individual preferences. An optional aerator *24* aerates the water flow *22* prior to expulsion from the spout *16* to provide improved flow uniformity. The faucet *12* is connected to hot and cold water supplies (not shown) through a hot water pipe *26* and a cold water pipe *28*, respectively. A drain *30* connects the basin *14* to a sewer or other water removal system (not shown). A strainer, stop *32* or other interface is optionally included at the entrance to the drain *30*. The handles *18*, *20* can employ compression valves, cartridge valves, or other valving mechanisms (not shown).

[0038] The lavatory *10* is exemplary only, and many variations thereof can be while remaining within the scope of the invention. For example, the two-control faucet *12* having two handles *18*, *20* can be replaced by a single-control faucet (e.g., FIGURE *6*) employing cartridge, ball, or disk-type washerless valves. Similarly, the illustrated embodiment shows a faucet *12* having a single raised base or deck *34*, which however could be replaced by a concealed deck or a wide-spread faucet design having separate mountings for the spout and the handles. The aesthetic aspects of the lavatory *10* are also broadly variable. For example, there are a wide range of

decorative spout designs commercially available. The invention embodiments described herein are readily adaptable to conform with all such variations. The invention embodiments are also readily adaptable to other types of bathroom plumbing fixtures such as showerheads (e.g., FIGURE *9*), and are furthermore readily adaptable to other types of fluid flow fixtures beyond the bathroom.

[0039] With continuing reference to FIGURE *1* , in one suitable embodiment of the invention, a night light *40* includes a light emitting diode (LED) *42* advantageously arranged to produce illumination *44* directed downward into the basin *14* . In one preferred embodiment, the LED *42* is a light emitting diode such as a phosphide-based red light emitting diode, a blue or blue/green nitride-based light emitting diode, a phosphor-coated UV light emitting diode that emits white or other colored light, or the like.

[0040] Those skilled in the art will recognize that such light emitting diodes are low voltage, low current devices with typical operating voltages of a few volts and typical operating currents of a few tens or hundreds of milliamperes. Thus, the safety concerns that exist regarding the arrangement of prior art incandescent or fluorescent lamp-based night lights in close vicinity to an accessible flow of water are alleviated. The LED *42* is powered by an electrical cable *46* connected to an electrical power supply (not shown). In a suitable embodiment, the power supply is a 120 volt a.c. house electricity in conjunction with an a.c./d.c. converter known to the art or other electrical circuit for reducing the supplied power to conform to the low voltage, direct low current power requirements of the LED *42* . It will be appreciated that the power conversion circuitry can be located well away from the lavatory *10* , e.g. at the wall power socket, to ensure the safety of the night light *40* by admitting only low voltage, low current controlled and limited power to the lavatory *10* via the cable *46* . Alternatively or in combination, a ground-fault-interrupt (GFI) protected AC outlet or other protected power source is employed to reduce the electrical shock hazard.

[0041] In one suitable embodiment, a class II power supply disposed away from the lavatory *10* is used to drive the LED *42* . As is known to those skilled in the art, the low voltage output of a class II power supply meets relevant electrical code requirements for use in the vicinity of the lavatory *10* , and is also sufficient to drive a

typical LED operating at a few volts and a few tens of milliamperes, e.g. 90 milliamperes. Alternatively, the circuitry can be located on or near the lavatory *10* in a hermetically sealed containment to minimize the electrical shock hazard.

[0042] In yet another suitable embodiment one or more dry-cell batteries are used. The batteries are suitably arranged in a battery pack located under or near the lavatory to provide easy access for battery replacement. It is also contemplated to use an inductively rechargeable battery such as are frequently employed in cardiac pacemakers. Since the inductively rechargeable battery does not need to be physically accessible for recharging, such a battery can be arranged inside the faucet or in other relatively inaccessible places.

[0043] With continuing reference to FIGURE *1* , the safety and low power consumption inherent in the low voltage, low current LED *42* makes it feasible to operate the night light *40* continuously. However, in the illustrated embodiment, an ambient light sensor *48* , such as a photodiode known to the art, is included to control the operation of the night light *40* . The sensor *48* produces a signal related to the intensity of the ambient light. In one preferred embodiment, the LED *42* is activated only when the sensor *48* indicates that the ambient light is below a selected threshold intensity.

[0044] FIGURE *2* shows another suitable lavatory embodiment *200* , in which a night light *240* includes a light emitting diode (LED) *242* arranged inside a modified aerator *224* . The night light *240* preferably uses a hermetically sealed light emitting diode for the LED *242* , so that it is impervious to the flow of water. Furthermore, because the LED *242* is a low voltage, low current device, there is no danger of electrical shock to the person using the lavatory *200* , even in the unlikely event of a failure of the hermetic sealing. Moreover, the extremely high reliability of hermetically sealed light emitting diodes compared with the much higher failure rates of incandescent or even fluorescent lamps ensures that the LED *242* will rarely if ever need to be replaced. In one contemplated embodiment, the aerator *224* and the LED *242* are manufactured as a single unitary component which is replaceable.

[0045] Because the LED *242* is actually contacting the water flow *22* , emitted light *244* is partially wave guided along the water stream *22* to provide direct illumination of the

stream *22*. This is particularly advantageous because the person using the lavatory *200* is usually interacting directly with the water flow *22*. This arrangement creates the visual effect that the water stream *22* itself is glowing with light, i.e. the water *22* appears to be the light source.

[0046] With continuing reference to FIGURE *2*, the LED *242* is a low power device which is suitable for continuous operation. However, in the embodiment shown, a pair of switches *260*, *262* (shown schematically) are linked to the hot and cold water handles *18*, *20*, respectively. The switches *260*, *262* connect the LED *242* to a power supply (not shown) through an electrical cable *264* running alongside or inside the spout *16*, and activate the LED *242* in response to opening of one or both of the handles *18*, *20*. In addition to advantageously conserving electrical power, in this arrangement LED *242* turns on and off in response to the flowing or lack of flow of the water stream *22*. This further adds to the aesthetic appeal by making it appear that it is the water stream *22* itself that is illuminated, or colored in the case of a colored LED *242*, since the illuminating only appears coincident with a water flow *22*.

[0047] In the illustrated embodiment of FIGURE *2*, on/off switches are shown, so that the illumination of the LED *242* appears fully on as soon as one of the handles *18*, *20* are opened. In another contemplated embodiment (not shown), the handles operate a variable resistance or other current controller which controls the amount of current applied to the LED *242*. In this manner the illuminating intensity depends upon the water flow *22* rate. In yet another variation (not shown), the LED *242* is replaced by two LEDs, one blue and one red. The blue LED is connected to the cold water handle while the red LED is connected to the hot water handle. In this manner, the water flow source (hot water or cold water) is indicated by the color of the water stream.

[0048] FIGURE *3* shows another suitable lavatory embodiment *300*, in which a night light *340* includes two light emitting devices (LEDs) *342*, one each associated with the hot and cold water handles *18*, *20*. The night light *340* advantageously illuminates the handles *18*, *20* which are the tactile target of a night-wandering person who wants to use the lavatory *300*. In this embodiment, the LEDs *342* are advantageously low power light emitting diodes that are operated continuously, such continuous operation being appropriate because the LEDs *342* illuminate only the handles *18*,

20, and therefore can be very low power devices. In an alternative embodiment (not shown), a light sensor such as the ambient light sensor *48* of FIGURE *1* is employed so as to activate the night light *340* only at night.

[0049] With reference to FIGURE *4*, another suitable lavatory embodiment *400* is shown. A night light *440* is essentially similar to the night light *340* of FIGURE *3*, except that here two light emitting devices (LEDs) *442*, which are again preferably light emitting diodes, are arranged within light transmissive handles *418*, *420* which are translucent or transparent. It will be appreciated that such an arrangement is possible because light emitting diodes can be manufactured as small, low power devices which radiate relatively little heat as compared with incandescent lamps. In one preferred embodiment, the handles *418*, *420* are replaceable components to facilitate replacement of the LEDs *442* in the unlikely event that an LED fails. It will be appreciated that the handles *418*, *420* are advantageously molded using a light transmissive material such as an acrylic resin to provide hermetic sealing of the LEDs *442*.

[0050] With reference to FIGURE *5*, yet another suitable lavatory embodiment *500* is shown, in which a night light *540* provides a visual indication of the temperature of the water flow *22*. The night light *540* includes two LEDs *542* of a first class, three LEDs *544* of a second class, and two LEDs *546* of a third class. In one suitable embodiment, the LEDs *542* of the first class are blue nitride-based light emitting diodes, the LEDs *544* of the second class are white phosphor-coated nitride-based light emitting diodes, and the LEDs *546* of the third class are red phosphide-based light emitting diodes. Of course other numbers and/or colors of LEDs can be employed.

[0051] With continuing reference to FIGURE *5*, the LEDs *542*, *544*, *546* are selectively operated by a controller *550*, which includes control circuitry typically embodied as an integrated circuit. In one suitable embodiment, the controller *550* includes an application-specific integrated circuit (ASIC) specifically designed for use in the night light *540*. The controller *550* receives a signal corresponding to a temperature of the water flow *22* from a temperature sensor *552*, which in a suitable embodiment is a temperature-sensitive resistor in thermal contact with the spout *16*. In a suitable

embodiment, the sensor *552* contacts the spout *16* but does not directly contact the water flow *22*, so that the temperature is indirectly measured. This indirect temperature measurement arrangement is suitable for spouts which are highly thermally conductive, such as metal spouts. In another suitable embodiment (not shown), the temperature sensor directly contacts the water flow *22*. In either arrangement, the controller *550* activates one or more of the LEDs *542*, *544*, *546* based on the output of the temperature sensor.

[0052] In a suitable embodiment, the LEDs *542* are activated when the temperature is below a selected lower threshold, thus indicating a cold water flow by a blue illumination. The LEDs *544* are activated when the temperature is within a preferred temperature range extending from the lower threshold to a selected upper threshold, thus indicating by a white, green, or other selected illumination hue that the preferred temperature range is achieved. The LEDs *546* are activated when the temperature exceeds the upper threshold, thus indicating by a red illumination that the water is too hot. Red is a preferred color to indicate that the upper temperature threshold has been exceeded because red is typically associated danger, and an overly hot water flow can be a dangerous condition. Optionally, the controller *550* causes the LEDs *546* flash when the temperature exceeds a danger threshold greater than the upper threshold, to even more strongly indicate to the night wandering person that the water flow *22* is extremely hot.

[0053] It will be appreciated that the embodiment of FIGURE *5* can, with minor modifications, be adapted to provide a visual indication of other operating parameters of a lavatory or other fluid flow fixture. For example, the temperature sensor *552* can be replaced by a flow meter which, along with appropriate changes to the control circuitry *550*, forms a night light that is responsive to the water flow rate. Similarly, the temperature sensor *552* can be replaced by an appropriate chemical sensor and appropriate changes to the control circuitry *550* to form an illuminated indicator responsive to the presence or absence of a selected chemical in the flow, which flow can be a water flow or a flow of another type of fluid.

[0054] With reference to FIGURE *6*, an embodiment *600* of the invention incorporating a centrally-located single-handle faucet *602* is described. Such faucets are well known

to the art, and typically are operated by pulling a handle knob *604* upward or away from the faucet *602* to turn on the water, and by rotating the knob *604* to selectively mix the hot and cold water supplies. In one common embodiment, the knob *604* is manufactured of an acrylic resin or other light-transmissive material, often with aesthetically pleasing facets for light reflection and light scattering. The faucet *602* also includes an aesthetically pleasing contoured spout *606* terminating in an aerator *608* for producing a water flow *610*, and the faucet is mounted on a base *612*. Instead of the base *612*, the faucet *602* could be mounted on a concealed deck (not shown). The faucet *602* operates in conjunction with a washbasin *14* and associated piping *26*, *28*, *30* and strainer or stop *32* which are essentially as described previously with respect to FIGURE *1*.

[0055] With continuing reference to FIGURE *6* and with further reference to FIGURES *7* and *8*, a night light *620* is mounted on a handle shaft *622* on which the handle knob *604* is disposed. The night light *620* includes a plurality of LED"s *624* arranged on a printed circuit (pc) board *626* shaped into an annular disk having a central opening *628* which receives the handle shaft *622*. The annular disk-shaped pc board *626* and the LEDs *624* disposed thereon are sealed by an encapsulant *630* to prevent damage to the electronics by water exposure. In a suitable embodiment, the encapsulant *630* is formed in a mold which conforms with a recess, surface, or feature *632* of the handle of the faucet *602* so that a surface *634* of the encapsulant *630* matingly fits into or onto the surface or feature *632*. The manufacturing of the night light *620* can be adapted to produce night lights compatible with a wide range of styles and designs of faucets by employing different suitable molds. It will further be appreciated that the night light *620* is particularly suitable for retro-fitting into existing single-handle faucets of various designs and styles.

[0056] The pc board *626* includes conductive traces (not shown) which interconnect the LEDs *624* and optional associated control elements such as a light sensor *636* to define electrical power and control circuitry for driving the LEDs *624*. Preferably, any associated elements such as the light sensor *636*, ASIC control and/or power circuitry (not shown) and the like are also sealed by the encapsulant *630* to form a hermetically sealed, waterproof unitary night light *620*. Power leads *638* pass through the encapsulant *630* and provide electrical power to the pc board *626*. The leads *638*

connect to an electrical line *640* leading to a class II power supply (not shown). Alternatively, a battery pack or other type of power supply is used.

[0057] With continuing reference to FIGURES *6 - 8*, the light sensor *636* detects the ambient light level. Responsive to the ambient light level decreasing below a selected turn-on light level criterion, the circuitry on the pc board *626* activates the LEDs *624* to produce light output *642* (indicated schematically by arrows in FIGURE 6) which is directed into the light transmissive knob *604*. The light *642* passes through the light-transmissive knob *604* and is also significantly scattered by the knob *604*. The knob *604* "glows" with the light *642*, providing illumination for the night-wandering person and making it particularly easy for such a person to locate the knob *604* in the dark.

[0058] With the arrangement shown in FIGURE *8*, wherein the light sensor *636* and the LEDs *624* are in close relative proximity (i.e., within range of optical communication), the spectral responsivity of the light sensor *636* is advantageously selected to be outside the spectral range of the LED light output *642*. This spectral separation reduces the possibility of undesirable interactions such as the light *642* of the LEDs *624* causing the light sensor *636* to shut off the LEDs *624*. Of course, the *630* should also be light-transmissive for the spectral range monitored by the light sensor *636*, and the spectral range monitored by the light sensor *636* should fall well within the ambient spectrum. In a suitable embodiment, the LEDs *624* emit light in the visible spectrum and the light sensor *636* monitors the infra-red spectrum and includes a visible light blocking filter.

[0059] With proper selection of relative spectral ranges, the light sensor *636* is suitably mounted on the pc board *626*. This arrangement is particularly convenient for electrical interconnection as the pc board *626* suitably includes conductive traces effectuating the interconnections. However, if a sensor other than an ambient light sensor is desired, such as a water temperature or flow sensor (not shown), the sensor is preferably located remotely from the pc board *626* where it can effectively monitor the desired parameter. In such a case, leads (not shown) additional to the power leads *638* are included to connect the remote sensor with the pc board *626*. In another contemplated variation, the LEDs *624* include a plurality of colors, and combined with appropriate circuitry on the pc board *626* and a temperature sensor (not shown)

implement a color indicator of temperature operatively similar to that of FIGURE *5*.

[0060] With reference to FIGURE *9*, another embodiment of a night light *650* suitable for use with a single-handle faucet similar to that of FIGURE *6* is shown. As is known to those skilled in the art, the knob *604* is typically connected with the shaft *622* by a threaded fastener which is accessed through a removable top portion *652* of the knob *604*. In such arrangements there is often an interior open volume *654* inside the *604* which is unused once the knob is affixed to the shaft *622*. As seen in FIGURE *9*, the night light *650* is suitably arranged in the open volume *654*. The night light *650* includes a disk-shaped pc board *656* with one or more LEDs, e.g. four LEDs *658* in FIGURE *9*, arranged thereon. The pc board *656* and the LEDs *658* are hermetically sealed by an encapsulant *660* which is advantageously formed using a mold to substantially conform with the open volume *654*. Electrical leads *662* are suitably passed through an opening (not shown) in the knob *604*.

[0061] The night light *650* is suitable for retro-fitting existing single-handle faucets. However, the retro-fitting of the night light *650* typically requires modifying the knob *604* by drilling or otherwise generating the opening for the leads *662*. Although not shown in FIGURE *9*, it will be appreciated that a light sensor or other controller elements are suitably included on the pc board *656* to provide selective illumination responsive to low ambient light or other conditions.

[0062] With reference to FIGURE *10*, an embodiment *700* incorporating a centrally-located single-handle faucet *702* is described. The faucet *702* is operated by pulling a handle knob *704* upward or away from the faucet *702* to turn on the water, and by rotating the knob *704* to selectively mix the hot and cold water supplies. The faucet *702* also includes a spout *706* terminating in an aerator *708* for producing a water flow *710*, and the faucet is mounted on a base *712*. Instead of the base *712*, the faucet *702* could be mounted on a concealed deck (not shown). The faucet *702* operates in conjunction with a washbasin *14* and associated piping *26*, *28*, *30* and strainer or stop *32* which are essentially as described previously with respect to FIGURE *1*. The faucet *702* also includes a lamp *720* mounted on a detachable lower cover plate *722* of the spout *706*. As is known to those skilled in the art, many commercial faucets include a detachable lower plate to provide convenient access to

the internal plumbing and valving of the faucet. The lamp *720* includes one or more LEDs and optional optics (not shown) to direct light *724* toward the water flow *710*. The light *724* is partially wave guided by the water stream *710* to illuminate the water flow *710*. Optionally, the lamp *720* includes a water flow sensor for selectively activating the LEDs responsive to initiation of water flow.

[0063] With continuing reference to FIGURE *10* and with further reference to FIGURE *11*, the lamp *720* is suitable for retro-fitting existing faucets. In a suitable retro-fit, the cover plate *722* is a replacement cover plate which includes LEDs *730* mounted thereon and which replaces the original lower detachable cover plate of the spout *706*. Optionally, associated optics such as lenses or filters (not shown) are also included to direct light produced by the LEDs *730* onto the water stream *710*. Because the lamp *720* is located underneath the spout *706*, it is likely to be exposed to water, soap, or other contaminants. Hence, the lamp *720* is sealed in an encapsulant *732*. A pc board (not shown) can be used in constructing the lamp *720*, in a manner similar to the embodiments *620*, *650* described previously. However, because of aesthetic concerns in having an exposed pc board on the spout, coupled with the design freedom provided by the detachable cover plate *722*, in the illustrated embodiment no pc board is employed in mounting the LEDs *730*.

[0064] Electrical connecting of the lamp *720* is particularly convenient because, as is well known to those skilled in the art, many centrally located single-handle faucets include a continuous open volume extending through significant portions of the spout and the handle region and accessible from the base *712*. Hence, as shown in FIGURES *10* and *11*, an electrical cord *734* connects with the LEDs *730* via an opening *736* in the cover plate *722*, runs through the open volume of the faucet *702* (this portion of the cord is shown as a dotted line in FIGURE *10*) and is accessible below or behind the lavatory *700*. In this manner, the lamp *720* presents an aesthetically pleasing appearance without exposed wires.

[0065] With reference to FIGURE *12*, a detachably attachable LED lamp *800* formed in accordance with the invention is described, for use with a showerhead *802* disposed on a distal end of a pipe or spout *804* connected to a shower wall *806*. The lamp *800* clamps onto the spout *804* in detachable manner by a clamping collar *808*. A plurality

of LEDs *810* are arranged on a slanted bottom portion *812* of the collar *808* oriented so as to provide illumination *814* (schematically shown as arrows) into the shower. Due to the moist environment, the LEDs *810* are sealed in an encapsulant *816*. The LEDs *810* are powered by a replaceable battery *818*, such as a button-type dry cell commonly used in watches, via appropriate wiring for example provided by a pc board (not shown). Optionally, selected feedback control is provided. In the exemplary lamp *800*, an ambient light sensor *820* is disposed on an opposite side of the collar *808* from the LEDs *810* for sensing ambient light conditions and activate the LEDs *810* under low light conditions. The ambient light sensor *820* is also preferably covered sealed by a light-transmissive encapsulant *822*.

[0066] In another contemplated embodiment, a thermal sensor (not shown) is arranged on an inside surface of the collar *808* in thermal contact with the spout *804*. In the case of a metal or other highly thermally conductive spout *804*, the spout temperature closely follows the temperature of the water flowing therethrough, and so the thermal sensor can be used to control an aspect of the LED light output. For example, the LEDs *810* can include blue and red LEDs which light up variably as the water temperature increases from cold to hot, starting at mostly blue for cold water, and shifting toward mostly red for a high water temperature. This provides visual feedback regarding the water temperature which can be useful when preparing the shower water flow for use. If the water temperature exceeds a selected threshold, the red LEDs optionally flash to provide a warning indicator. Because the operator is often watching a control handle *830* for controlling water flow from the showerhead *802* during the preparation, it is also contemplated to arrange temperature-indicating blue, white, and red LEDs thereon. Of course, other colors besides the blue/white/red combination can also be employed.

[0067] With reference to FIGURE *13*, another shower LED lamp embodiment *840* is shown. The lamp *840* is located under the handle *830*, mounted on a showerhead flow control handle shaft *842* on which the handle *830* is disposed. This mounting arrangement is similar to the mounting arrangement of the faucet handle night light *620* described with reference to FIGURE *7*. The faucet handle *830* is preferably light transmissive so that light *844* (schematically represented by arrows) produced by the LED lamp *840* transmits through the handle *830*. The LED lamp *840* optionally

includes an ambient light sensor, thermal sensor, or other controlling sensor element, a printed circuit board with controller circuitry arranged thereon, or like elements (not shown).

[0068] With reference to FIGURE *14*, a suitable electrical circuit *850* for controlling an LED used for a night light is described. The circuit *850* includes, among other circuit elements, a voltage source *852*, a photoresistor *854*, a transistor *856*, and a first LED *858*. Current flows in the channel of the transistor *856* responsive to light on the photoresistor *854* dropping below a selected intensity. The transistor current drives the first LED *858*. Optionally, a second LED *860* is also energized responsive to operation of a manual switch *862*. The circuit *850* is suitable, for example, to drive the night light *620* or the night light *650* of FIGURES *8* and *9*, respectively, which provide night lighting responsive to a low light level. The circuit *850* is suitably embodied as circuitry arranged on the printed circuit board *626* of the night light *620* or on the printed circuit board *656* of the night light *650*. The second LED *860* is suitably embodied by the LED lamp *720*, shown in FIGURES *10* and *11*, which illuminates the water stream *710*.

[0069] With reference to FIGURE *15*, a suitable analog electronic circuit *880* includes a plurality of operational amplifiers (op amps) *882* cooperating with other circuit elements to control a red LED *884* and a blue LED *886* based on a water temperature input. A thermistor *888* in thermal contact with the water stream cooperates with a reference resistor *890* to provide a voltage reference indicative of the water temperature. The circuit *880* provides relatively stronger illumination from the red *884* and weaker illumination from the blue LED *886* responsive to a high temperature. At a predetermined high temperature threshold, the circuit *880* causes the red LED *884* to blink indicating an uncomfortably or dangerously high temperature. The circuit *880* provides relatively stronger illumination from the blue LED *886* and weaker illumination from the red LED *884* responsive to a cool temperature. The circuit *880* is suitable, for example, to drive the LED lamp *800* of FIGURE *12* when using a thermal sensor, i.e. the thermistor *888*.

[0070] With reference to FIGURE *16*, yet another suitable electronic circuit *900* for controlling a multi-color LED combination based on a water temperature is shown. A

thermistor *902* in thermal contact with the water stream cooperates with a reference resistor *904* to provide a voltage reference indicative of the water temperature. A microcontroller *906* cooperates with additional circuit elements to provide pulse width modulation (PWM) control of power input to a plurality of LEDs *908*, *910* of selected colors. The microprocessor-based circuit *900* is suitable, for example, for use in the lavatory *500* shown in FIGURE *5*.

[0071] The circuits *850*, *880*, *900* of FIGURES *14* - *16* are exemplary only. Those skilled in the art can modify these circuits or provide other electrical arrangements that are suitable for specific applications and embodiments of the invention.

[0072] The invention has been described with reference to the preferred embodiments. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.